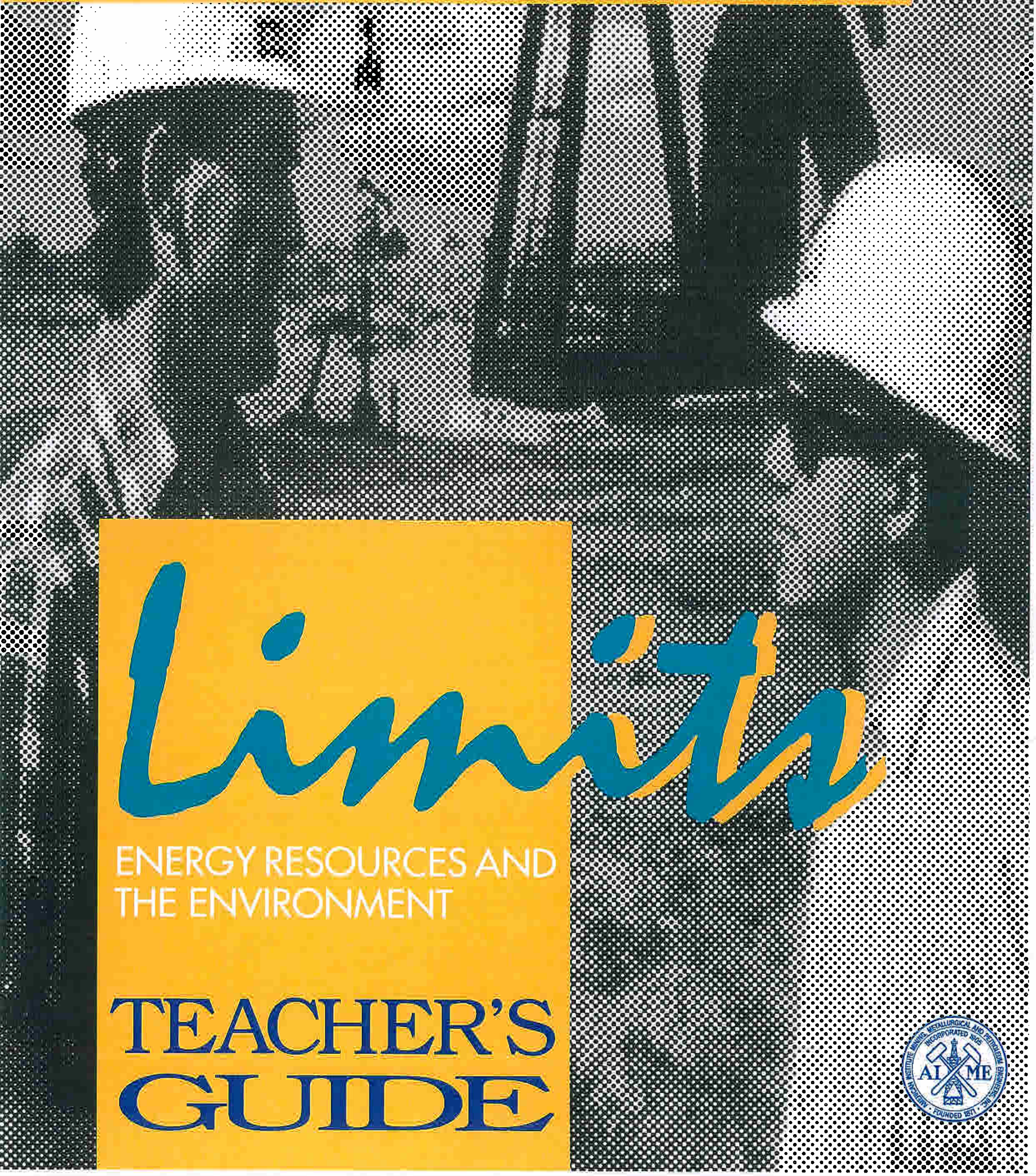
TRANSFORMATIONS
SCIENCE, TECHNOLOGY & SOCIETY



Limits

ENERGY RESOURCES AND THE ENVIRONMENT

TEACHER'S GUIDE

Program Goals

- ▲ to enhance and enrich science instruction in Middle School classrooms
- ▲ to explore ways that technology takes scientific knowledge and applies it to meeting society's needs and solving society's problems
- ▲ to foster among students a spirit of inquiry, encouraging and developing their problem-solving skills
- ▲ to help create citizens who are cricital thinkers, prepared to make informed decisions about complex social/technological issues that will confront them in decades to come

LIMITS

Energy Resources and the Environment

The subject of this unit is the different sources of our nation's energy supply. The accompanying video features visits to an oil field in west Texas and a project for developing economical photovoltaic power in New Mexico. Below are the topics for "Limits," presented in this Guide.

- ▲ Renewable Resources
- ▲ Fossil Fuels
- ▲ Energy and the Environment

Curriculum Connections: Earth Science, General Science, Physical Science; a literature unit on the environment or conservation.

Summary of the Video

Billy arrives at the garage late because his "gas-guzzling" car ran out of gas. Talk of running out of gas leads Billy to Perry Jarrell, an engineer at an oil field, who reveals some of the technologies developed to extract as much petroleum as possible, including water injection and CO_2 injection.

What other fuels could be used to power cars? As the band members discuss alternatives — electricity, coal, hydroelectric power, nuclear power — they realize each has its drawbacks. Laurie points to solar power. Her suggestion leads to a visit with Margie Whipple, who explains and demonstrates some of the work being done with photovoltaic cells and solar concentrators. Laurie also learns of the problems associated with using solar power.

The theme song for "Limits" is "Dangerous Curves":

You're running on empty
Down a highway to nowhere
How far do you think you'll go?

you're telling me "later"
But it won't last forever
So, baby, you better go slow

The love limit's posted
And the light's flashing red
You're headed for disaster
Round those curves up ahead
Those dangerous curves ahead.

Suggestion for Using Unit C: "Limits" Resources

Page 3 — Introduction to the Teacher

Here you will find additional background information on the science and technology presented in "Limits."

Page 4 — Introduction to the Students

This section gives you material for introducing "Limits" to your students, including a statement of the purpose of the unit; suggestions for connecting the unit to students' experience; definitions of key concepts and terms; and directions for the Video Study Guide (see below).

Page 5 — Topic 1 | **Page 6 — Topic 2** | **Page 7 — Topic 3**

These pages focus on the three major topics in "Limits": Renewable Resources, Fossil Fuels, and Energy and the Environment. Each page furnishes options for introducing the topic to students and a wide array of ways for students to respond to the topic, including labs that are carried out through the Activity Masters.

Choose any of the topics as your focus, depending on where you are in the curriculum.

Video Study Guide

You can use the video guide (Activity Master 1) to focus students' attention on and check their comprehension of the video.

Video

Running time for the video is 17 minutes. You may want to preview the video and choose a Stop Point for conducting a discussion, carrying out an activity, or making a comprehension check. The video may also be show straight through.

Pages 8-13 — Activity Masters

The first blackline master is the Video Study Guide for "Limits." The other masters give students hands-on opportunities in the form or activities and labs.

Page 14 — Extension

This final section includes suggestions for science fair projects and research topics, ones that build on concepts explored in "Limits." Also listed are related resources for interested students to pursue, including book titles and organizations to contact.

LIMITS: An Introduction for the Teacher

"Limits" investigates our different energy sources, brings out the advantages and disadvantages associated with each, and gives students a sense of how technology is used to solve problems so that we can meet our energy needs.

Below is a more detailed explanation of concepts presented in the video and developed in this Guide.

How are oil and gas formed?

When decaying marine organisms (mostly microorganisms) on the ocean floor were buried and compacted, thermal and chemical reactions occurred that produced petroleum (crude oil) and natural gas. Earth pressure forced the oil and gas up out of the source rocks into more permeable rock beds until stopped by a cap rock, such as shale. When present in a petroleum reservoir, natural gas is at the top, since it is lightest. Oil, which is lighter than water, is found above the water that forms at the reservoir bottom.

What is enhanced recovery?

When an oil reservoir is first tapped, it usually produces oil under natural pressure. At the end of this first, primary phase, typically 80% of the petroleum remains underground.

Secondary recovery involves water injection, using existing wells to force water into the reservoir and pushing the petroleum toward a producing well, where it is pumped out. This may recover another 25% of the reserve.

Different tertiary recovery technologies are under development. "Limits" presents a major installation in west Texas that injects carbon dioxide under high pressure. The CO_2 mixes with the petroleum and helps leach it out of the reservoir rock.

Even then, however, an estimated 30% of the petroleum will remain trapped underground.

How do photovoltaic cells work?

The cells are made by sandwiching two thin layers of silicon. The two layers contain two different impurities that react to light in different ways. When light hits the bottom layer, it frees electrons from the silicon atoms. These electrons migrate to the top layer of silicon. The resulting imbalance in electrons forms a negative charge on the top layer and a positive charge on the bottom. An electric current flows when the two layers are connected to a conductor.

What is acid rain?

When pollutants, such as sulfur and nitrogen oxides, are released into the air, they combine with water vapor to form sulfuric and nitric acids that return to Earth in the form of acid rain or snow. Certain forms of coal contain high levels of sulfur, which are released when the coal is burned.

Acid rain can kill plants and animal life in certain lakes, damage buildings, and may reduce crop yields. Technical advances to reduce sulfur emissions include treating the coal with bacteria that consume sulfur, producing a harmless by-product; crushing and washing the coal; or using a gasification process.

What is the relationship between the greenhouse effect and global warming?

When CO_2 and other "greenhouse gases" accumulate in the atmosphere, they allow the sun's shortwave radiation to reach Earth's surface but prevent reradiated infrared wavelengths from leaving the atmosphere, thus trapping the heat. This is the greenhouse effect. Many scientists believe that the greenhouse effect will lead to a global climate warming of a few degrees centigrade. This warming could cause a partial melting of the polar ice caps and flooding, on the one hand, and droughts and the creation of new deserts on the other.

The greenhouse effect is a fact grounded in the laws of physics. Global warming is a hypothesis that has not been proved.

LIMITS: An Introduction for Students

Introducing the Unit

Present the goals of "Limits" to your students:

- ▲ to find out what fuel resources our society can use to meet its needs
- ▲ to realize that there are advantages and disadvantages associated with each resource
- ▲ to get a sense of the problem-solving techniques that scientists and engineers bring to bear on fuel production and environmental issues
- ▲ to develop a sense of personal responsibility for making energy choices

Students should **not** feel, however, that they must fully learn and memorize the processes discussed in the video.

Connecting the Exploration to Students' Experience

Have students recall the Persian Gulf War that ended in January of 1991. Make sure the issue of our having free access to oil in the gulf is part of the discussion about the reason for the war.

Point out that during this war, President Bush released his National Energy Strategy Act of 1991, sending the bill to Congress in March. Among its measures is a call for research and development into finding new and better technologies for natural gas production, "clean coal" procedures, and the utilization of alternative energy sources.

Key Concepts and Terms

Students will be exploring and extending their understanding of the words listed below (in bold face) by topic area. You might write these words on the board and briefly discuss them to determine which are familiar to your students.

Topic: Renewable Resources

- ▲ The terms **renewable/nonrewable** and, less often, **replaceable/nonreplaceable,** are used to categorize fuel resources. The distinction is between resources that quickly convert the sun's energy to a usable form—such as trees, hydro and wind power, solar heating or photovoltaic cells—and those that are produced so slowly that they cannot possibly be replaced as quickly as they are used. Examples of nonrenewable resources include oil, natural gas, and coal.
- ▲ The term **solar energy** is used to describe renewable energy resources. By contrast, fossil fuels are stored solar energy. And nuclear, geothermal, and tidal power are not solar in origin.
- ▲ A **photovoltaic cell** is a device that changes light, from the sun or other light source, directly into electricity.

Topic: Fossil Fuels

- ▲ **Fossil fuels** are the remains of ancient plants and animals. The plants absorbed energy from the sun; the animals ate the plants. When fossil fuels are burned, their solar energy is released.
- ▲ Fossil fuels—such as oil, natural gas, and coal—are **nonrenewable** resources that are burned to provide thermal energy, which can be used to heat buildings, run machines, or generate electricity.
- ▲ **Enhanced recovery techniques** are ways of getting as much oil and natural gas out of the earth as possible.
- ▲ One enhanced-recovery technique involves the injection of **carbon dioxide**—CO_2, which provides the carbonation in soft drinks.
- ▲ CO_2 is injected into the **trap,** the reservoir of oil that has soaked into rock the way water soaks into a sponge.
- ▲ Oil and water don't mix. Neither do CO_2 and oil—unless pressure is exerted. Under pressure, the CO_2 becomes **miscible,** mixing with the oil to form a froth.

Topic: Energy and the Environment

- ▲ Burning fossil fuels releases gases that contribute to the **greenhouse effect** and, possibly, to **global warming.**
- ▲ Burning some coal releases sulfur into the air; it combines with water vapor to form sulfuric acid—**acid rain.**

VIDEO STUDY GUIDE

To focus or direct students' viewing of the video, distribute Activity Master 1, the Video Study Guide. You might have your students work individually, or small groups could each be responsible for a particular section of the Study Guide. Allow time—stopping the video at various points or after the video is over—for students to discuss their responses.

LIMITS: Renewable Resources

Introducing the Topic: Options

- Write **renewable resources** and **nonrenewable resources** on the board. Ask students to come up with definitions that include one or two examples. This can be done quickly with the whole class. Or, have students work in small groups or cooperative pairs; students could then vote for the best definitions.
- Divide the class into small groups, and have each group come up with a cycle in nature (such as seasonal changes in deciduous trees, seasonal changes in temperature, or the water cycle), noting the cycle steps. With the class, rank cycles by duration— from quickest to slowest—on the board. Draw a line at the bottom, and write **mineral and fossil deposits**. Tell students that these are considered nonrenewable, since their cycles take millions of years.
- Materials needed: **solar powered calculator**. Demonstrate the calculator to students by punching in some numbers to create a display. Cover the photovoltaic cells with your fingers so that the numbers fade out. Take your fingers away to bring back the display. Ask students to compare this event to the effect of a cloud passing overhead on an outdoor photovoltaic cell.

STUDENT INVOLVEMENT: OPTIONS

Indicates an activity that would take less than a class period.

Indicates an activity that could take most of a class period.

Indicates an activity that would go beyond the class period.

Discuss the Video

Video Guide notes can be used to help students answer these and other straightforward questions:

- What nonrenewable resource was discussed at length in the video? (oil)
- What renewable resource was discussed at length in the video? (sun)
- Margie, the solar engineer, gives examples of what solar energy would be good for and what it would not be good for. What are the examples? (not good—steel mill; good in Third World countries without electricity for irrigation pumps and refrigerators)

Group Discussion Possibilities

- All fuel resources, nonrenewable or renewable, are really renewable. Explain. (They are all replaced some very slowly.) Think of other adjectives that could categorize the two types of fuels.
- Do you agree or disagree with these statements? Why or why not?

  Our energy needs are more important than what happens to the earth.

  People should stop driving cars so that we can conserve fuel.

Group Brainstorming: Solar Pro's and Con's

Have students brainstorm the pro's and con's of solar energy as you record their ideas on the board. Then ask students to vote pro or con solar energy. (Pro's: renewable; won't run out; doesn't pollute; available to all nations; technology exists. Con's: initial cost is high; clouds can affect amount of sunlight; the sun doesn't shine at night; sunlight varies by location and season.)

Lab: Creating Your Own Solar Concentrators (Activity Master 2)

Materials Needed: See master. Each lab group constructs a simple solar concentrator. If weather allows, have students work outside. If you want to conserve materials, ask students to submit designs, pick ones to construct, and use those concentrators for all classes. **Caution: If students are using mercury filled thermometers, monitor them closely; exposed mercury can be a health hazard.**

ANSWERS: Graph x-axis = time, y-axis = temperature. 1. Results should be higher temperatures for the concentrators; 2. can without concentrator; 3. concentrator; 4. to make conditions equal; 5. curve flattens out at 100°C, the boiling point of water.

Homework: Solar Energy and Land Use

It is estimated to take one square mile of photovoltaic cells to provide enough electricity for 15,000 people. How much land would be needed to supply electricity for a city of 240,000? An average city that size covers 64 sq. mi. What percent of that area would be needed for the cells? Do you think this a wise use of land and money? Why or why not?

ANSWERS: 1. 16 sq. mi.; 2. 25%; answers will vary.

LIMITS: Fossil Fuels

Introducing the Topic: Options

- To briefly introduce the topic to students, draw a circle on the board. Mark out a 10% wedge (the arc of the wedge would be from 12 o'clock to just beyond 1 o'clock). Darken the larger area, and inform students that fossil fuels account for 90% of our energy use.
- Do a small group brainstorming to stress our dependence on fossil fuels. Write two sentences on the board: **Many things are made from fossil fuels—plastics, nylon, polyester, shoe polish, photographic film, records, tapes, CD's. Many things are manufactured in processes that burn fossil fuels—think how many factories have smokestacks**. Divide students into small groups, and have them brainstorm a list of all the items they are wearing or carrying that depend in some way on fossil fuels. Allow time for students to share and compare their lists.
- Materials needed: **beaker, pebbles, cooking oil, water**. Help students understand oil reservoirs by conducting a demonstration. Fill a beaker with pebbles, which represent the grains in sandstone, a common reservoir rock. Tell students that sandstone grains touch, but pore spaces remain. Pour water over the pebbles until it fills the spaces in the bottom third of the beaker—just as water sits at the bottom of a reservoir. Add cooking oil to fill another third, reminding students that oil is less dense than water, so it floats. Explain that here pore spaces above the oil are filled with air, but in an oil reservoir, they might be filled with natural gas, which is lighter than oil.

STUDENT INVOLVEMENT: OPTIONS

Indicates an activity that would take less than a class period.

Indicates an activity that could take most of a class period.

Indicates an activity that would go beyond the class period.

Discuss the Video

Video Guide notes can be used to help students answer these and other straightforward questions:

- Which is a better description of how oil exists underground—like a lake or like a sponge? Why?

  Sponge—oil soaks into rock pores.

- What techniques can engineers use to get oil out of the ground? Are they 100% effective?

  Drilling, pumping, water and CO_2 injection; no—some 30% is left.

Group Brainstorming: Something for Nothing?

Write on the board: **It takes energy to make energy** and the connected phrases **undiscovered oil /gas in your car**. Divide the class into small groups, and direct them to brainstorm the steps leading from one phrase to the other. Ask them to identify which steps require energy (to change or transport the oil) and which steps add to the cost. Have students pool their results.

Activity: Making a Good Recovery (Activity Master 3)

Students, in pairs or groups, analyze a geologic map and make recommendations of how best to use an oil field. You may want to let students role play the culmination of this activity, with several students playing the president and board of directors while a team of engineers gives its report.

Answers: 1. 9, 10; 2. 2 and 8; 3. 3, 4, 5, 6, and 7. For bulleted questions: water is cheaper and is usually attempted before CO_2 injection; 3 and 7—they are at the sides of the existing trap; increased production in 4, 5, and 6.

Activity: Comparing Fossil Fuels (Activity Master 4)

Have students brainstorm ways in which houses can be heated. Point out that coal burning furnaces have been replaced by oil, propane, electric, or natural gas heaters; ask why (less messy, cleaner to burn, easier to use and transport). Divide students into groups or cooperative pairs to complete the activity; afterward, share and discuss graphs, and perhaps, do sample interpretations.

Answers: 1. 720,000 BTUs; 2. $2.70, $3.60; 3. coal; 4. coal is a dirty fuel to use and burn, gasoline is expensive and dangerous.

Homework: What's in a Barrel of Oil?

One barrel of crude oil contains 42 gallons. At a refinery, this oil is broken down into different petroleum products. The typical yield per barrel is 45.9% gasoline, 28.6% fuel oil, 9.6% jet fuel, 3.2% asphalt, 0.6% waxes, and 12.1% miscellaneous products. How many gallons of each product is derived from one barrel of oil? (gas: 19.3; fuel oil: 12; jet fuel: 4; asphalt: 1.3; waxes: .3; miscellaneous: 5.1)

LIMITS: Energy and the Environment

Introducing the Topic: Options

▲ Do a quick group brainstorming about energy's impact on the environment. Have students name energy resources, and list them on the board. For each, ask students whether they think the resource does or doesn't harm the environment. If it can be harmful, have students identify possible problems, and put an X for each one beside the relevant energy resource. Put a + beside those termed harmless.

▲ Materials needed: **candle, matches, mirror**. Demonstrate the Law of the Conservation of Energy: Tell students that energy can neither be created nor destroyed; it can only change form. Remind them that most wax is derived from the refinement of oil. As you light the candle, ask students to guess what will happen when the wax "burns up." Hold a mirror above the flame for a few seconds, so students can see black soot forming. They may also see water droplets form and evaporate. Explain that as fossil fuels burn, they consume oxygen and release water vapor and CO_2.

▲ Materials needed: **shallow pan, sand, water, motor oil, cardboard, cotton balls, pipe cleaners, paper towels.** Work with students to create an oil spill. Bank sand at one end of a shallow pan. Fill the pan about an inch deep with water. Add a small amount of motor oil to the water. Have a student create waves at the other end of the pan by moving a piece of cardboard back and forth, parallel to the "beach." Ask students how they would clean up the spill. Have the listed cleaning supplies handy for experimentation.

STUDENT INVOLVEMENT: OPTIONS

- Indicates an activity that would take less than a class period.
- Indicates an activity that could take most of a class period.
- Indicates an activity that would go beyond the class period.

Discuss the Video

Video Guide notes can be used to help students answer these and other straightforward questions:

▲ What energy sources do band members discuss? Which do they think is best?

Electricity, gas, coal, water, nuclear power, wind, sun—all have problems.

▲ Technology has created some problems, but it is also the way to solve our energy problems. What examples did you find in the video of problem solving?

Getting more oil out of the ground, cleaning coal, using solar energy effectively.

Group Discussion: an Energy Debate

Randomly assign students to committees: oil and natural gas supporters, coal supporters, solar energy supporters, nuclear energy supporters, and hydroelectric supporters. Each group should prepare arguments for why theirs is the best energy source. Remind them to consider the problems associated with their source and to think of ways to deal with the problems. Allow time for the presentation of arguments and discussion.

Lab: A Model Greenhouse

Materials needed: (for each lab group): **clear plastic soda bottle with cap—with a hole you have punched near the top, 2 thermometers, watch, 4x10 piece of construction paper, graph paper**. Review the greenhouse effect before dividing students up into lab groups. Have each group insert the construction paper (with a different color for each group) into the bottle. Students then place the bottle in the sunlight and take temperature readings every two minutes for 30 minutes, by inserting one thermometer through the hole. The second thermometer is used to simultaneously take temperature readings of the air outside the bottle. Have students record their readings on a data sheet and create graphs. Ask: 1. What is the control? 2. How did the two sets of readings compare? 3. How does paper color affect temperature? 4. How is the model like Earth's greenhouse effect?

ANSWERS: 1. readings outside bottle; 2. those inside bottle are higher; 3. the darker the color, the higher the temperature; 4. paper absorbs sunlight; plastic prevents reradiation.

Homework: What's Our Share?

The biggest contributor to the greenhouse effect is CO_2. Each year some 6 billion tons of carbon are released into the air by burning fossil fuels. The U.S., a world leader in fighting pollution, is still responsible for 24% of that carbon. The U.S. population is about 250 million. How much carbon do we put into the air each year? How much is that per person?

ANSWERS: 1. 1.44 billion tons; 2. 5.76 tons.

VIDEO STUDY GUIDE

This guide is designed to help you get the most out of the video for "Limits." Look over the questions below before you watch the video. Use the space under the question to take notes. What does the video tell you in answer to the question?

1. Which is a better description of how oil exists underground—like a lake or like a sponge? Why?

2. Is oil a renewable or nonrenewable resource? How long does it take for oil to form?

3. What techniques can engineers use to get oil out of the ground? Are they 100% effective?

name: ______________________ **class:** ________ **date:** __________

VIDEO STUDY GUIDE, continued

4. What sources of energy do the band members discuss? Which energy source do they think is best?

5. Do you agree or disagree with this statement? Why or why not? STATEMENT: Since solar energy is renewable, electricity from the sun is almost free.

6. Margie, the solar engineer, gives examples of what solar energy would be good for and what it would **not** be good for. What are the examples?

7. What parts of the video did you like best? Why?

name: ______________________ class: ________ date: __________

CREATING YOUR OWN SOLAR CONCENTRATOR

Margie, an engineer in the video, explained how solar concentrators are used to focus sunlight on photovoltaic cells, which convert sunlight into electricity.

Here's a chance for you to be an engineer. Below is all the information you need to design a solar concentrator that you can see work — just like the real thing.

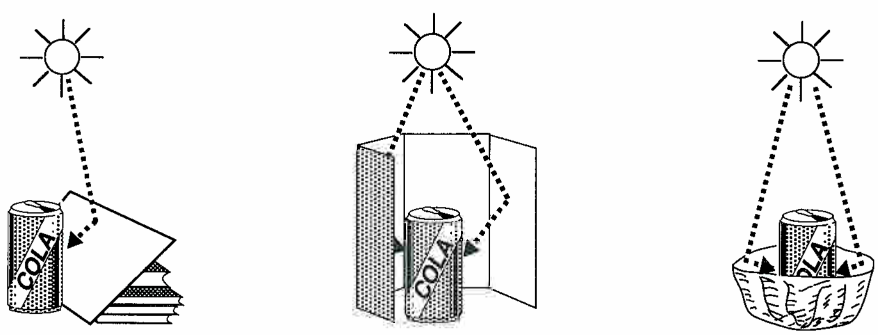
Begin by reading through the instructions (both pages), and then divide up into your lab groups.

MATERIALS NEEDED

For each lab group:

- ▲ 2 identical soda cans
- ▲ Aluminum foil
- ▲ Cardboard — if you need backing
- ▲ Fasteners — such as tape, a stapler, or paper clips
- ▲ Scissors
- ▲ A beaker — for measuring water
- ▲ Water
- ▲ Thermometer
- ▲ Graph paper and colored pencils

STEP 1. Design your concentrator, using the foil with cardboard and fasteners as needed. The aluminum foil will focus the sunlight, like a real concentrator. The point is to focus as much light as possible on one of the soda cans. Use your imagination, but keep in mind that your concentrator must stay in place and not tip over.



STEP 2. Put 100 mL of water in each soda can.

STEP 3. Move outside to set up your experiment: Set one water-filled can on a flat surface in the sunlight. Set your concentrator (with the second water-filled can) on the same surface in the same light. Experiment with concentrator angle until you focus as much light as possible on the can.

STEP 4. Use the thermometer to measure the temperature of the cans.

Caution: Be careful handling the thermometer. If it breaks, tell your teacher immediately.

name: ______________________ **class:** ________ **date:** __________

SOLAR CONCENTRATOR, continued

STEP 5. Record the temperatures and time on the data table below. Take readings every 2 minutes.

DATA TABLE		
	TEMPERATURE OF WATER IN CANS IN C°	
TIME	can without solar concentrator	can with solar concentrator
0 minutes		
2 minutes		
4 minutes		
6 minutes		
8 minutes		
10 minutes		
12 minutes		
14 minutes		
16 minutes		

Graph your results. Use different colors for the two sets of temperatures.

What will you put on the x-axis of your graph? ____________________

What will you put on the y-axis? ____________________

Use your data table and graph to answer these questions.

1. How would you compare the temperature changes in the two cans?

   ____

   ____

2. Which can was the control? ____________________
3. What was the variable in this experiment? ____________________
4. Why did the cans have to be placed on the same surface? __________

   ____

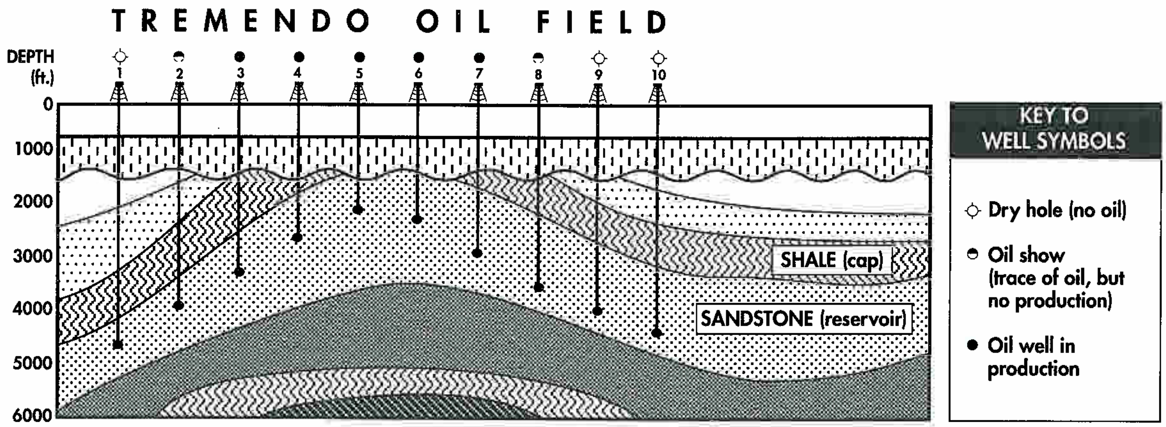
5. At what temperature does the water temperature flatten out — that is, it won't go any higher? ____________________

name: ____________________ **class:** __________ **date:** __________

MAKING A GOOD RECOVERY

Below is a map of a cross-section of the earth. It shows how the layers of rock in a particular area are arranged underground. Some layers have folded up in the middle. This is called an anticline. Two layers are labeled— the rock containing the oil trap, as well as the cap rock. (Remember, the pressure of the earth forces oil to move upward; cap rock is dense rock that oil cannot penetrate.)

Use the map to answer the questions below.



1. Which wells in the Tremendo Oil Field are not producing oil?______________________________

2. Which wells have **shows** of oil, indicating that there is oil nearby?

____

3. Which wells are producing oil? ____________________

You are a petroleum engineer with Humongeous Oil. You know that the outer oil producing "edge" wells are not profitable—they are on pumps and mainly producing water plus a few barrels of oil per day. The remaining oil producing wells are also on pumps but are still producing a fair amount of oil.

You have to make a presentation to the president of the company, telling what you think should be done with the Tremendo Oil Field. On a separate piece of paper, write your recommendations. Use your answers to these questions to help you set up your paper:

▲ What method of enhanced recovery would you recommend? Water injection? CO_2 injection? Explain your choice.

▲ Which wells would you inject? Why?

▲ What would be the results?

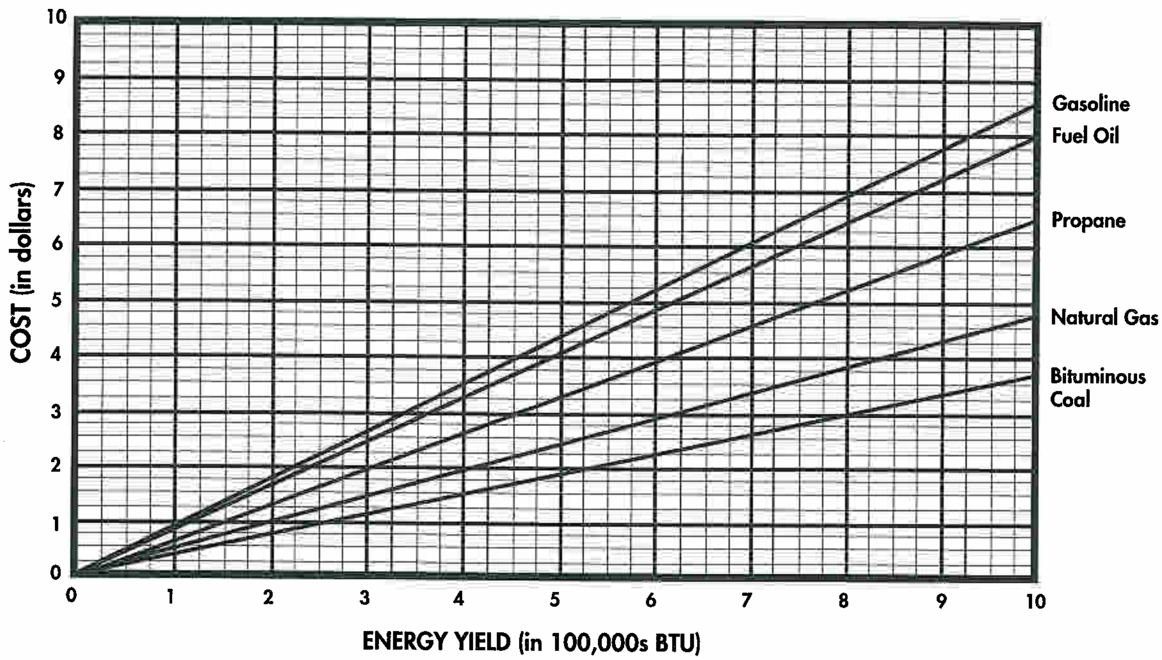
name: ____________________ **class:** ________ **date:** ________

COMPARING FOSSIL FUELS

Fossil fuels now account for 90% of our energy. You've seen that burning fossil fuels can have an impact on our environment. What about their impact on your family's pocketbook? Home owners choose fuels based on availability (what kinds of fuel do they have access to?) and on cost.

The graph below shows data for fossil fuels used in home heating. The prices are approximate. BTUs—British thermal units—are used to measure thermal (heat) energy in fuel. One BTU is the amount of energy needed to raise the temperature of one pound of water one degree Fahrenheit.

Use the graph to answer the questions below.



1. Burning $5.00 worth of fuel oil yields how many BTUs? ________
2. What does it cost to get 750,000 BTUs using coal? ____________
   Using natural gas? ______________
3. Based on cost, which is the least expensive fuel per BTU?__________
4. Most homes not heated by electricity are heated by fuel oil, propane, or natural gas. Why do you think gasoline and coal are not used as much as the other fuels?

____

____

name: ______________________________ **class:** ________ **date:** __________

LIMITS: Extension

Interested students may wish to pursue ideas and concepts raised by this exploration. You could direct them to the suggestions and resources listed on this page.

Possible Research Topics

- ▲ Compare and contrast the use of solar energy and fossil fuels.
- ▲ Investigate the global warming theory — predictions and arguments; the international movement to limit greenhouse emissions to forestall warming.
- ▲ Present the history of acid rain—causes, effects, the search for cures.
- ▲ Survey new car models to compile and compare the EPA driving rates for city and highway.
- ▲ Interview a mechanic at a local car inspection station to find out about automobile emission controls—what are they? How are they measured?
- ▲ Find out which sites are best for using wind power. Chicago is called "The Windy City"—does that make it a good site?

Suggested Science Fair Projects

- ▲ What are the effects of acid rain on radish plants?
- ▲ What are the effects of acid rain on brine shrimp?
- ▲ What is the effect of temperature on electrical conductivity?
- ▲ Can solar energy cook a hot dog efficiently? Melt an ice cube?

Resource Center

Books to recommend:

Energy by Melvin Berger (Franklin, 1983).

Energy in America by Irene Kiefer (Atheneum, 1980).

Future Sources of Energy by Mark Lambert (Bookwright, 1986).

The Future World of Energy by John H. Douglas (Franklin, 1984).

Global Warming by Laurence Pringle (Macmillan, 1990).

The Greenhouse Effect: Life on a Warmer Planet by Rebecca L. Johnson (Lerner, 1990).

Nuclear Energy: Troubled Past, Uneven Future by Laurence Pringle (Mamcillan 1989).

Oil! Getting It, Shipping It, Selling It by Elaine Scott (Frederick, 1984)

Rain of Troubles: the Science and Politics of Acid Rain by Laurence Pringle (Macmillan, 1988).

Sea Otter Rescue: the Aftermath of an Oil Spill by Roland Smith (Cobblehill, 1990)

Small Energy Sources: Choices That Work by Augusta Goldin (HBJ, 1988).

Solar Energy by Wilbur Cross (Childrens, 1984).

Organizations to contact:

Alliance to Save Energy
1725 K Street, NW
Suite 914
Washington, DC 20006
(202) 857-0666

American Petroleum Institute
Public Relations
2101 L Street NW
Washington, DC 20037

National Petroleum Council
Director of Information
1625 K Street NW
Washington, DC 20006

Office of Public Information
Bureau of Mines
U.S. Department of the Interior
2401 E Street NW
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